A-68944

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Examiner: Anthony Dexter Tugbang
STUART J. KNOWLES ET AL.	
Serial No. 09/615,294	Group Art Unit 3729
Filed: July 13, 2000	Confirmation No. 4777
For: METHOD OF MANUFACTURING A TUNING FORK WITH REDUCED QUADRATURE ERROR AND SYMMETRICAL MASS BALANCING	June 26, 2008

APPLICATION FOR PATENT TERM ADJUSTMENT

Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Sir:

Pursuant to 37 CFR 1.705(b), applicant requests reconsideration of the patent term adjustment indicated in the notice of allowance and reinstatement of all or part of the term reduced pursuant to 37 CFR 1.704(b).

Facts

The Patent Term Adjustment History (Exhibit A) contains a number of errors and inaccuracies which have resulted in an incorrect and improper reduction of the patent term adjustment.

The most significant such error is the 454 days that were charged against applicant for delay in responding to a non-final action mailed November 18, 2002. A timely response to that action was filed by mail with a certificate of mailing (Exhibit B) on February 14, 2003, and the return postcard submitted with the response (Exhibit C) shows that it was received in the Patent Office Mail Room on February 24, 2003. The PTA History is incorrect in showing that response as not having been filed until May 17, 2004, and the 454 days should not have been charged to applicant.

Applicant was also incorrectly charged for a delay of 39 days in responding to a non-final rejection mailed September 14, 2001. A timely response to that action was filed by mail with a certificate of mailing (Exhibit D) on December 14, 2001, although it was apparently not processed in the Patent Office Mail Room until January 22, 2002.

Applicant acted with complete diligence and due care in responding within three months of the mailing date of the action, and any mail delays or processing delays in the Patent Office were obviously beyond applicant's control. With no delay on applicant's part, the 39 days should not have been charged to applicant.

The delay occasioned by the failure of the Patent Office to respond within four months to the response filed February 14, 2003 (37 CFR 1.702(a)(2)) was not included in the calculation of the patent term adjustment. The Examiner's next action was not mailed until May 28, 2004, *i.e.* 15 months and 11 days after the response was filed, which constituted a delay of 346 days by the Patent Office.

Moreover, the Patent Office delay due to successful appellate review (37 CFR 1.702(e)) was actually 1061 days, starting with the filing of the notice of appeal on June 24, 2005 and ending with the BPAI decision reversing the Examiner's rejection, mailed May 19, 2008.

Finally, the failure of the Patent Office to issue a patent within three years of the filing date of the application (37 CFR 1.702(b)) does not appear to have been included in determining the patent term adjustment. The original application was filed July 13, 2000, and a request for continued examination was filed August 29, 2002. Using the filing date of the request for continued examination and the issue date projected in the notice of allowance (December 23, 2008), it will have taken the Patent Office 6 years, 3 months, and 25 days after the filing date to issue the patent. Thus, the delay in issuing the patent is 3 years, 3 months, and 25 days, or a total of 1213 days.

The patent is not subject to a terminal disclaimer.

Calculation of Patent Term Adjustment

The incorrect calculation of the patent term adjustment shown on the notice of allowance is based on 700 Patent Office delay days and 521 applicant delay days, resulting in an adjustment of only 179 days.

Patent Office Delay Days

The correct calculation of the Patent Office delay days is the 700 days included in the notice of allowance, plus the 346 days for the delay in acting on the response filed

February 14, 2003, plus 431 additional days for the delay due to appellate review,[1] plus 152 days for the failure to issue a patent within three years,[2] a total of 1629 days.[3]

Applicant Delay Days

Although applicant believes that there were no circumstances constituting a failure to engage in reasonable efforts to conclude processing or examination of the application as set forth in 37 CFR 1.704, the correction requested in the applicant delay days is the 521 days included in the notice of allowance, minus only the 454 days for the response filed February 14, 2003, and the 39 days for the response filed December 14, 2001, leaving a total of 28 days of delay charged to applicant.

Conclusion

With 1629 Patent Office delay days and 28 applicant delay days, it is respectfully submitted that the patent term should be extended by a period of 1601 days.

The Commissioner is authorized to charge any fees required in this matter to Deposit Account 50-2975, Order No. A-68944.

Respectfully submitted,

Edward S. Wright

Edward S. Wright
Registration No. 24,903

Law Offices of Edward S. Wright
1100 Alma Street, Suite 207
Menlo Park, CA 94025
Telephone: (650) 330-0830
Facsimile: (650) 330-0831

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[1] 1061 days minus the 631 days included in the original calculation.

[2] 1213 days minus the 1061 days of appellate review.

[3] Even with only 631 days of appellate delay as in the original calculation, the total Patent Office delay would still be 1629 days because the adjustment for failure to issue a patent within three years would be decreased by only the 631 days rather than 1031 for the appellate delay.

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CERTIFICATE OF FACSIMILE TRANSMISSION

THIS CORRESPONDENCE IS BEING FORWARDED TO THE PATENT OFFICE FOR FILING VIA FACSIMILE TRANSMISSION TO (571) 273-8300 ON June 26, 2008.

Edward S. Wright

EDWARD S. WRIGHT

EXHIBIT A

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09/615,294	Method of manufacturing a tuning fork with reduced quadrature error and symmetrical mass balancing	06-20-2008::17:45:28

Patent Term Adjustments

Patent Term Adjustment (PTA) for Application Number: 09/615,294

Filing or 371(c) Date:	07-13-2000	USPTO Delay (PTO) Delay (days):	700
Issue Date of Patent:	-	Three Years:	-
Pre-Issue Petitions (days):	+0	Applicant Delay (APPL) Delay (days):	521
Post-Issue Petitions (days):	+0	Total PTA (days):	179
USPTO Adjustment(days):	+0	Explanation Of Calculations	

Patent Term Adjustment History

Date	Contents Description	PTO(Days)	APPL(Days)
06-11-2008	Mail Notice of Allowance		
06-09-2008	Document Verification		
06-09-2008	Notice of Allowance Data Verification Completed		
06-09-2008	Case Docketed to Examiner in GAU		
05-19-2008	Mail BPAI Decision on Appeal - Reversed	631	
05-19-2008	BPAI Decision - Examiner Reversed	↑	
11-08-2007	Docketing Notice Mailed to Appellant	↑	
11-08-2007	Assignment of Appeal Number	↑	
08-27-2007	Appeal Awaiting BPAI Docketing	↑	
08-15-2007	Mail Reply Brief Noted by Examiner	↑	
08-13-2007	Reply Brief Noted by Examiner	↑	
06-19-2007	Date Forwarded to Examiner	↑	
05-15-2007	Reply Brief Filed	↑	
05-10-2007	Exam. Ans. Review Complete	↑	
03-15-2007	Mail Supplemental Examiner's Answer	↑	
03-14-2007	2nd or Subsequent Examiner's Answer to Appeal Brief	↑	
01-10-2007	Appeal Brief Review Complete	↑	
01-10-2007	Date Forwarded to Examiner	↑	
12-05-2006	Appeal Brief Filed		24
11-28-2006	Notice -- Defective Appeal Brief		↑
09-12-2006	Date Forwarded to Examiner		↑
08-28-2006	Defective / Incomplete Appeal Brief Filed		↑
08-28-2006	Appeal Brief Filed		↑
08-28-2006	Notice of Appeal Filed		↑
08-11-2006	Mail Post-examiner ans. com		↑
08-09-2006	Post-examiner ans. com		
07-26-2006	Order Returning Undocketed Appeal to the Examiner		
07-20-2006	Appeal Awaiting BPAI Docketing		
07-17-2006	Mail Reply Brief Noted by Examiner		
07-10-2006	Reply Brief Noted by Examiner		
04-28-2006	Date Forwarded to Examiner		

04-24-2006	Reply Brief Filed		
02-23-2006	Mail Examiner's Answer	61	
02-21-2006	Examiner's Answer to Appeal Brief	↑	
12-15-2005	Date Forwarded to Examiner	↑	
12-13-2005	Appeal Brief Filed	↑	
11-16-2005	Notice -- Defective Appeal Brief	↑	
08-30-2005	Date Forwarded to Examiner	↑	
08-24-2005	Defective / Incomplete Appeal Brief Filed	↑	
08-24-2005	Appeal Brief Filed	↑	
07-19-2005	Mail Advisory Action (PTOL - 303)		
07-13-2005	Advisory Action (PTOL-303)		
07-07-2005	Date Forwarded to Examiner		
06-24-2005	Amendment/Argument after Notice of Appeal		
06-24-2005	Notice of Appeal Filed		
07-05-2005	Date Forwarded to Examiner		
06-24-2005	Amendment after Final Rejection		
06-15-2005	Mail Final Rejection (PTOL - 326)		
06-13-2005	Final Rejection		
04-05-2005	Date Forwarded to Examiner		
03-17-2005	Response after Non-Final Action		
01-18-2005	Reference capture on IDS		
01-18-2005	Information Disclosure Statement (IDS) Filed		
01-18-2005	Information Disclosure Statement (IDS) Filed		
12-17-2004	Mail Non-Final Rejection		
12-13-2004	Non-Final Rejection		
09-23-2004	Date Forwarded to Examiner		
08-17-2004	Response after Ex Parte Quayle Action		
09-21-2004	Correspondence Address Change		
08-17-2004	Workflow incoming amendment IFW		
08-11-2004	Mail Ex Parte Quayle Action (PTOL - 326)		
08-09-2004	Ex Parte Quayle Action		
06-01-2004	IFW TSS Processing by Tech Center Complete		
06-01-2004	Date Forwarded to Examiner		
05-17-2004	Response after Non-Final Action		454
04-19-2004	Miscellaneous Incoming Letter		↑
05-27-2004	Correspondence Address Change		↑
05-17-2004	Workflow incoming amendment IFW		↑
11-18-2002	Mail Non-Final Rejection		↑
11-18-2002	Non-Final Rejection		
09-12-2002	Date Forwarded to Examiner		
09-12-2002	Date Forwarded to Examiner		
09-03-2002	Request for Continued Examination (RCE)		4

09-12-2002	DISPOSAL FOR A RCE/CPA/129 (express abandonment if CPA)		↑
09-03-2002	Workflow - Request for RCE - Begin		↑
05-30-2002	Mail Final Rejection (PTOL - 326)	8	
05-28-2002	Final Rejection	↑	
03-06-2002	Date Forwarded to Examiner	↑	
01-22-2002	Response after Non-Final Action		39
11-06-2001	Case Docketed to Examiner in GAU		↑
09-14-2001	Mail Non-Final Rejection		↑
09-10-2001	Non-Final Rejection		
06-04-2001	Case Docketed to Examiner in GAU		
07-19-2001	Case Docketed to Examiner in GAU		
07-06-2001	Date Forwarded to Examiner		
06-29-2001	Response to Election / Restriction Filed		
06-05-2001	Mail Restriction Requirement		
06-04-2001	Requirement for Restriction / Election		
10-10-2000	Information Disclosure Statement (IDS) Filed		
10-10-2000	Information Disclosure Statement (IDS) Filed		
10-13-2000	Case Docketed to Examiner in GAU		
10-04-2000	Application Dispatched from OIPE		
08-25-2000	Correspondence Address Change		
08-07-2000	IFW Scan & PACR Auto Security Review		
07-13-2000	Initial Exam Team nn		

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EXHIBIT B

A-68944
ESW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

STUART J. KNOWLES ET AL.

Serial No. 09/615,294

Filed: July 13, 2000

For: METHOD OF MANUFACTURING A TUNING FORK WITH REDUCED QUADRATURE ERROR AND SYMMETRICAL MASS BALANCING

Examiner:
Anthony Dexter Tugbang

Group Art Unit 3729

February 14, 2003

AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

This Amendment is responsive to the Office Action mailed November 18, 2002, and in the revised format announced at 1265 Off. Gaz. Pat. Office 87 (Dec. 17, 2002).

CERTIFICATE OF MAILING

I HEREBY CERTIFY THAT THIS AMENDMENT IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS FIRST CLASS MAIL IN AN ENVELOPE ADDRESSED TO: ASSISTANT COMMISSIONER FOR PATENTS, WASHINGTON, D.C. 20231, ON FEBRUARY 14, 2003.

Edward S Wright
EDWARD S. WRIGHT

AMENDMENTS TO THE SPECIFICATION

Page 1, lines 1 - 13

Background

Field of Invention

This invention pertains generally to tuning forks for use in rate sensors and, more particularly, to a tuning fork and method in which mass balance is maintained when quadrature error is reduced.

Related Art

Tuning fork rate sensors make use of the Coriolis effect to sense rotation. The tuning fork is driven to oscillate in a drive move in which the tines oscillate in a plane with roughly equal and opposite amplitudes. Under rotation, the tines experience a Coriolis acceleration proportional to the velocity of the tines and in a direction orthogonal to the drive motion. In a double-ended tuning fork, the orthogonal acceleration excites a pickup mode of vibration which causes both the driven set of tines and the other (pickup) set to vibrate out of the plane of the device. In quartz rate sensors, this out-of-plane vibration is detected piezoelectrically in a manner well known in the art.

Page 2, line 27 to Page 3, line 8

U.S. Patent 4,379,244 discloses a tuning fork which has electrodes near the stem of the fork for detecting a voltage which is indicative of asymmetrical oscillation of the tines. A laser is used for removing mass from the front surfaces of the tines in order to provide a symmetrical oscillation of the tines and thus a balanced condition. While this technique may result in a balanced fork, it is not useful in tuning fork rate sensors because it does not provide any adjustment of the quadrature output, and the quadrature offset would, in general, remain quite large.

Objects of the Invention and Summary

It is in general an object of the invention to provide a new and improved tuning fork and method of manufacture.

Page 3, lines 12 - 20

These and other objects are achieved in accordance with the invention by providing a tuning fork and method in which a pair of elongated tines having front and rear surfaces are disposed symmetrically about an axis, and balancing masses on the front surface of one tine and on the rear surface of the other tine are trimmed to reduce quadrature error and also to maintain mass balance between the tines.

Brief Description of the Drawings

Figure 1 is a top plan view of one embodiment of a tuning fork incorporating the invention.

Page 4, lines 1 - 10

Figure 3 is a view similar to Figure 2, illustrating the balancing masses after trimming to reduce quadrature error.

Detailed Description

As illustrated in Figure 1, the tuning fork has a pair of drive tines 11, 12 and a pair of pickup tines 13, 14 which extend in opposite directions from a central body or base 16 and are disposed symmetrically about the longitudinal axis 17 of the device. The body includes a frame 18 which surrounds a central opening 19, with a mounting pad 21 within the opening connected to the frame by relatively thin bridges 22. The tuning fork is formed as a unitary structure of a piezoelectric material such as quartz. Drive and pickup electrodes (not shown) are mounted on the tines in a conventional manner.

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AMENDMENTS TO THE CLAIMS

1 - 3. (Withdrawn)

4. (Previously Amended) In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, and using balancing masses on the front surface of one tine and the rear surface of the other tine to ~~eliminate~~ reduce quadrature displacement in the tines and maintain a balance in mass between the tines.

5. (Previously Amended) In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, applying mass elements to the tines, and removing portions of the mass elements from the front surface of one tine and from the rear surface of the other to ~~eliminate~~ reduce quadrature displacement in the tines and maintained a balance in mass between the tines.

6. (Previously Amended) In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, and adding mass elements to the front surface of one tine and the rear surface of the other tine to ~~eliminate~~ reduce quadrature displacement in the tines and maintained a balance in mass between the tines.

7. (Previously Amended) In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines having free ends of increased lateral dimension with laterally offset balancing masses on opposite sides of the tines near the free ends, and adjusting the balancing masses on opposite sides of the two tines to ~~eliminate~~ reduce quadrature displacement in the tines and maintain a balance in mass between the tines.

PAGE 13/33 * RCVD AT 6/26/2008 5:06:51 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-6/20 * DNIS:2738300 * CSID:650 330 0831 * DURATION (mm-ss):03-58

8. (Previously Amended) The method of Claim 7 wherein the balancing masses are adjusted by removing substantially equal amounts of the balancing masses from the opposite sides of the two tines.

9. (Previously Amended) The method of Claim 7 wherein the tines are fabricated of a material which is transparent to a laser beam, and the balancing mass on one side of one of the tines is trimmed by passing the laser beam through the tine to the balancing mass.

10. (Previously Amended) The method of Claim 7 further including the step of removing substantially equal amounts of the balancing masses from same sides of the tines to adjust the drive mode frequency of the tuning fork.

11. (Previously Amended) In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming an elongated pair of drive tines having front and rear surfaces, forming a pair of pickup tines having front and rear surfaces, applying balancing masses to the front and rear surfaces of the drive tines, and trimming the balancing masses on opposite sides of the drive tines to ~~eliminate~~ reduce quadrature displacement without affecting mass balance between the drive tines.

12. (Previously Amended) The method of Claim 11 further including the step of trimming the masses on same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

13. (Original) The method of Claim 11 further including the steps of providing masses on the pickup tines, and trimming the masses on the pickup tines to adjust the pickup mode frequency of the tuning fork.

14. (Previously Amended) In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, applying balancing masses to the front and rear surfaces of the tines, trimming the balancing masses if necessary to provide a balance in mass between the two tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface

of one of the tines and from the rear surface of the other to ~~eliminate~~ reduce quadrature displacement in the tines and maintain the balance in mass between tines.

15. (Previously Added) The method of Claim 14 together with the step of removing substantially equal amounts of the balancing masses from same sides of the two tines to adjust the drive mode frequency of the tuning fork.

16. (Previously Amended) In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming elongated pairs of drive and pickup tines which have front and rear surfaces and extend in opposite directions from a central body, applying balancing masses to the front and rear surfaces of the drive tines, trimming the balancing masses if necessary to provide a balance in mass between the drive tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the drive tines and from the rear surface of the other to ~~eliminate~~ reduce quadrature displacement in the drive tines and maintain the balance in mass between them.

17. (Previously Added) The method of Claim 16 further including the step of removing substantially equal amounts of the balancing masses from same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

18. (Previously Added) The method of Claim 16 further including the steps of applying balancing masses to the pickup tines, and removing substantially equal amounts of the balancing masses from same sides of the pickup tines to adjust the pickup mode frequency of the tuning fork.

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REMARKS

In deference to the Examiner's request, headings are being added to the specification. However, applicant would respectfully remind the Examiner that these headings are a matter of preference, not something which is required by either the statute or Rules.

Claims 4 - 18 have all been rejected under 35 U.S.C. §112, first paragraph, as containing subject matter which was not described in the specification in a way which would convey that the inventor had possession of the invention at the time the application was filed.

In making that rejection, the Examiner has questioned whether the original specification supports claiming elimination of quadrature error displacement "completely altogether". In so doing, the Examiner is reading something into the claims which is not there. The claims do not call for eliminating quadrature displacement completely or altogether; they simply say "to eliminate quadrature displacement", and that limitation is met by eliminating any part of that displacement. Rather than belaboring the issue, "eliminate" is being changed to "reduce", and with that amendment, applicant trusts that the rejection will be withdrawn.

Claims 4 - 18 have all been rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the invention. This rejection is based on the same issue as the other one, and with the amendment of "eliminate" to "reduce", applicant trusts that it, too, will be withdrawn and that the application will be passed to issue.

The Commissioner is authorized to charge any fees required in this matter, including extension fees, to Deposit Account 50-2319, Order No. A-68944/ESW.

Respectfully submitted,

By Edward S. Wright

Edward S. Wright
Registration No. 24,903

(650) 494-8700

EXHIBIT C

In the United States Patent and Trademark Office

File No.: A-68944/ESW	Serial No.: 09/615,294	Filing Date: July 13, 2000
Date Due: February 18, 2003	Date Mailed: February 14, 2003	Express Mail No.:

Applicant: Stuart J. Knowles, et al.

Title: *METHOD OF MANUFACTURING A TUNING FORK WITH REDUCED QUADRATURE ERROR AND SYMMETRICAL MASS BALANCING*

Enclosure:	
• xx Amendment	Acknowledge receipt of the enclosures by imprinting Patent Office "date stamp" here and returning to addressee noted on reverse

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PATENT & TRADEMARK OFFICE

EXHIBIT D

A-68944
ESW

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

STUART J. KNOWLES ET AL.

Serial No. 09/615,294

Filed: July 13, 2000

For: METHOD OF MANUFACTURING A TUNING FORK WITH REDUCED QUADRATURE ERROR AND SYMMETRICAL MASS BALANCING

Examiner: Dexter Tugbang

Group Art Unit 3729

December 14, 2001

AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

In response to the Office Action mailed September 14, 2001, please amend this application as follows:

IN THE TITLE

Amend the title to read as follows:

METHOD OF MANUFACTURING A TUNING FORK WITH REDUCED QUADRATURE ERROR AND SYMMETRICAL MASS BALANCING

IN THE SPECIFICATION

Amend Page 4, lines 1 - 2 to read as follows:

Figure 3 is a view similar to Figure 2, illustrating the balancing masses being trimmed with a laser to reduce quadrature error.

Amend Page 1, lines 12 - 20 to read as follows:

The mass elements can be trimmed by any suitable means such as a laser 30. In one presently preferred embodiment, the tines are fabricated of a material such as crystalline quartz which is transparent to the laser beam, and all of the masses are trimmed from the same side of the fork. Thus, for example, the laser might be positioned on the front side of the fork, with the laser beam 30a passing through the fork to trim elements 28, 29 on the back sides of the tines. Alternatively, if desired,

the laser beam can be directed to the back sides of the tines by other means such as mirrors, or by turning the tuning fork over.

Amend Page 6, lines 18 - 24 to read as follows:

It is not necessary that the two tines be substantially equal in mass and stiffness prior to adjustment for quadrature offset. If there is an imbalance between the tines, either by design or by errors in fabrication, that imbalance can be corrected by first trimming the mass on one of the tines to eliminate the imbalance, and then trimming equally from both tines for subsequent adjustment. In this way, an inherently asymmetric fork can be corrected as part of the quadrature reduction and frequency adjustment process.

IN THE CLAIMS

Amend the Claims to read as follows:

4. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, and using balancing masses on the front surface of one tine and the rear surface of the other tine to eliminate quadrature displacement in the tines while maintaining a balance in mass between the tines.

5. The method of Claim 4 wherein quadrature displacement is eliminated and mass balance is maintained by applying mass elements to the tines, and removing portions of the mass elements from the front surface of one tine and from the rear surface of the other.

6. The method of Claim 4 wherein quadrature displacement is eliminated and mass balance is maintained by adding mass elements to the front surface of one tine and the rear surface of the other tine.

7. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines having free ends of increased lateral dimension with laterally offset balancing masses on opposite sides of the tines near

the free ends, and adjusting the balancing masses on opposite sides of the two tines to eliminate quadrature displacement in the tines while maintaining a balance in mass between the tines.

8. The method of Claim 7 wherein the balancing masses are adjusted by removing substantially equal amounts of them from the opposite sides of the two tines.

9. The method of Claim 7 wherein the tines are fabricated of a material which is transparent to a laser beam, and the balancing mass on one side of one of the tines is trimmed by passing the laser beam through the tine to the balancing mass.

10. The method of Claim 7 further including the step of removing substantially equal amounts of the balancing masses from same sides of the tines to adjust the drive mode frequency of the tuning fork.

11. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming an elongated pair of drive tines having front and rear surfaces, forming a pair of pickup tines having front and rear surfaces, applying balancing masses to the front and rear surfaces of the drive tines, and trimming the balancing masses on opposite sides of the drive tines to eliminate quadrature displacement without affecting mass balance between the drive tines.

12. The method of Claim 11 further including the step of trimming the masses on same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

13. The method of Claim 11 further including the steps of providing masses on the pickup tines, and trimming the masses on the pickup tines to adjust the pickup mode frequency of the tuning fork.

14. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, applying balancing masses to the front and rear surfaces of the tines, trimming the balancing masses if necessary to provide a balance in mass between the two tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the tines and from

the rear surface of the other to eliminate quadrature displacement in the tines while maintaining the balance in mass between them.

15. The method of Claim 14 together with the step of removing substantially equal amounts of the balancing masses from same sides of the two tines to adjust the drive mode frequency of the tuning fork.

16. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming elongated pairs of drive and pickup tines which have front and rear surfaces and extend in opposite directions from a central body, applying balancing masses to the front and rear surfaces of the drive tines, trimming the balancing masses if necessary to provide a balance in mass between the drive tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the drive tines and from the rear surface of the other to eliminate quadrature displacement in the drive tines while maintaining the balance in mass between them.

17. The method of Claim 16 further including the step of removing substantially equal amounts of the balancing masses from same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

18. The method of Claim 16 further including the steps of applying balancing masses to the pickup tines, and removing substantially equal amounts of the balancing masses from same sides of the pickup tines to adjust the pickup mode frequency of the tuning fork.

REMARKS

As requested by the Examiner, the title is being amended and the use of the laser beam is now shown in the drawings, and applicant trusts that the objections to the specification and drawings will be withdrawn.

Claims 7 - 10 and 12 have been rejected under 35 U.S.C. §112 as being indefinite because the Examiner says that they do not particularly point out and distinctly claim the invention. Most of the language to which the Examiner has objected is being eliminated. However, contrary to the Examiner's suggestion, there is no antecedent

problem or uncertainty in with regard to the term "mass" in Claim 7. The balance in mass between the tines is a balancing of the overall masses of the tines, including the tines themselves and the balancing masses, and it is maintained by adjustment of the balancing masses in the manner specified. It would not be correct to say that a balance in the mass of just the enlarged areas is maintained as suggested by the Examiner. With this explanation and the amendments which are being made, applicant trusts that the rejection will be withdrawn.

Claims 4 - 6 have been rejected under 35 U.S.C. §102 as being anticipated by Macy (U.S. 5,522,249). Reconsideration and withdrawal of this rejection is requested.

While applicant's invention and Macy may both be concerned with the elimination of quadrature error, they do so in different ways. In Macy, the pickup electrodes are trimmed to produce an electrical null in the quadrature signal, whereas in applicant's invention balancing masses are utilized to eliminate quadrature vibration and to maintain a balance in mass between the tines. One is an electrical technique; the other is mechanical.

The electrical balancing technique of Macy is quite different than applicant's invention. In the single-ended tuning fork of Macy, piezoelectrically induced drive charge is present on the pickup electrodes. If this charge is not perfectly symmetrical in its distribution on the various pickup electrodes, there will be a net quadrature signal in the output since the drive charge signal is in quadrature phase relation to the rotation-induced Coriolis signal. By trimming away electrode area, an intentional change in the electrode symmetry is created to produce an electrical nulling of the quadrature signal.

Contrary to the Examiner's suggestion, the pickup electrodes in Macy are not balancing masses. Their function is to provide electrically conductive regions for sensing piezoelectrically induced charge, and their mass is insignificant. Such electrodes are typically only 100 - 200 nm thick, whereas balancing masses as

employed in applicant's invention may be as thick as 10,000 nm and a relatively heavy metal such as gold.

The location of the pickup electrodes relatively close to the base of the tines in Macy also makes their mass less significant since they are farther away from the free ends of the tines which move with significantly more velocity than the areas near the base.

In contrast, in applicant's invention, there is a true mechanical balancing in which the mechanical properties of the tines are altered such that the actual quadrature displacement in the pickup mode of vibration is reduced or eliminated.

Claim 4 is being amended in order to clarify the important difference between applicant's invention and the electrical nulling in Macy. It distinguishes over the prior art in calling for the step of to eliminate quadrature displacement in the tines while maintaining a balance in mass between the tines.

Claim 5 depends from Claim 4 and further distinguishes over Macy in specifying that quadrature displacement is eliminated and mass balance is maintained by applying mass elements to the tines and removing portions of the mass elements from the front surface of one tine and from the rear surface of the other. The fact that the mass is removed from opposite sides of the two tines is important, and it is not even remotely suggested by Macy. Removing mass from only one side of a tine reduces quadrature displacement, and removing it from the opposite side of the other tine increases the reduction. Removing equal amounts from both tines maintains the balance in mass between the tines as the quadrature displacement is eliminated.

Claim 6 also depends from Claim 4 and further distinguishes over Macy in specifying that quadrature displacement is eliminated and mass balance is maintained by adding mass elements to the front surface of one tine and the rear surface of the other tine. As noted above, Macy does not disclose the reduction or elimination of quadrature displacement, and it does not suggest the addition of balancing masses to the tines.

Claims 7, 8 and 10 have been rejected under 35 U.S.C. §103 as being unpatentable over Macy in view of Fujiwara et al. (U.S. 4,468,582). Macy is discussed above, and Fujiwara et al. shows a single piezoelectric plate with electrodes which are trimmed to adjust the frequency of the device. Although the electrodes may be trimmed with a laser, they cannot be trimmed through the plate because they are not offset as in applicant's invention. In that regard, it will be noted that electrode patterns 311, 312 block access to the so-called adjuster electrodes 331, 332 on the opposite sides of the plate.

The Examiner is also mistaken in suggesting that Macy teaches laser trimming of balancing masses affects the pickup and drive mode frequencies of the tuning fork. As discussed in the paragraph bridging Columns 7 and 8 of Macy, the difference in frequency (delta f) between the pickup and drive modes is adjusted by proper dimensioning of the tines and the stem of the fork so that the pickup mode includes torsional rotation of the stem as well as flexing of the tines out of the plane of vibration.

Claim 7 distinguishes over Macy and Fujiwara et al. in calling for the steps of forming a pair of elongated tines having free ends of increased lateral dimension with laterally offset balancing masses on opposite sides of the tines near the free ends, and adjusting the balancing masses on opposite sides of the two tines to eliminate quadrature displacement in the tines while maintaining a balance in mass between the tines. With no teaching of mass balancing or elimination of quadrature displacement in the references, the rejection is clearly improper.

Claim 8 depends from Claim 7 and further distinguishes in specifying that the balancing masses are adjusted by removing substantially equal amounts of them from the opposite sides of the two tines. As discussed above, this technique of removing mass is not even remotely suggested by the references, and it eliminates quadrature displacement without affecting mass balance.

Claim 10 also depends from Claim 7 and further distinguishes over the references in calling for the step of removing substantially equal amounts of the balancing masses

from same sides of the tines to adjust the drive mode frequency of the tuning fork. Neither reference even remotely suggests removing equal amounts of balancing mass from the same sides of the two tines of a tuning fork.

Claim 9 has been rejected under 35 U.S.C. §103 as being unpatentable over Macy in view of Fujiwara et al. and further in view of Praschek et al. (U.S. 5,296,674). Macy and Fujiwara are discussed above, and Praschek et al. is cited as showing the removal of material from one side of a substrate with a laser passing through the substrate. There is no motivation whatsoever for combining the various teachings of these references in the manner proposed by the Examiner, and even if they were combined in that manner, they would not produce the invention.

Claim 9 depends from Claim 7 and distinguishes over the references for the same reasons as its parent claim. In addition, it further distinguishes in specifying that the tines are fabricated of a material which is transparent to a laser beam, and the balancing mass on one side of one of the tines is trimmed by passing the laser beam through the tine to the balancing mass. This is an important improvement in the prior art because it permits the balancing masses on opposite sides of the tines to be trimmed with a laser on one side of the tines. That is not possible in prior art such as Fujiwara et al. where the electrodes are not offset and the electrode on one side would prevent the laser beam from getting to the other.

Claims 11 - 13 have been rejected under 35 U.S.C. §103 as being unpatentable over Macy et al. (U.S. 4,930,351) in view of Macy. Macy is discussed above, and Macy et al. appears to be cited only for its teaching of a double-ended tuning fork. Neither reference even remotely suggests mass balancing and the elimination of quadrature displacement as in applicant's invention.

Claim 11 distinguishes over Macy et al. and Macy in calling for the steps of forming an elongated pair of drive tines having front and rear surfaces, forming a pair of pickup tines having front and rear surfaces, applying balancing masses to the front and rear surfaces of the drive tines, and trimming the balancing masses on opposite

sides of the drive tines to eliminate quadrature displacement without affecting mass balance between the drive tines.

Claims 12 and 13 depend from Claim 11 and further distinguish in calling for the steps of trimming the masses on the same sides of the drive and pickup tines to adjust the drive and pickup mode frequencies of the tuning fork. As discussed above, that makes it possible to adjust those frequencies independently of each other and without disturbing either the quadrature displacement or the mass balance.

In order to more fully round out the protection to which applicant is believed to be entitled, new Claims 14 - 18 are being added. Claim 14 distinguishes over the references in calling for the steps of forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, applying balancing masses to the front and rear surfaces of the tines, trimming the balancing masses if necessary to provide a balance in mass between the two tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the tines and from the rear surface of the other to eliminate quadrature displacement in the tines while maintaining the balance in mass between them.

Claim 15 depends from Claim 14 and further distinguishes in calling for the step of removing substantially equal amounts of the balancing masses from same sides of the two tines to adjust the drive mode frequency of the tuning fork.

Claim 16 distinguishes over the references in calling for the steps of forming elongated pairs of drive and pickup tines which have front and rear surfaces and extend in opposite directions from a central body, applying balancing masses to the front and rear surfaces of the drive tines, trimming the balancing masses if necessary to provide a balance in mass between the drive tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the drive tines and from the rear surface of the other to eliminate quadrature displacement in the drive tines while maintaining the balance in mass between them.

Claim 17 depends from Claim 16 further distinguishes in calling for the step of removing substantially equal amounts of the balancing masses from same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

Claim 18 also depends from Claim 16 further distinguishes in calling for the steps of applying balancing masses to the pickup tines, and removing substantially equal amounts of the balancing masses from same sides of the pickup tines to adjust the pickup mode frequency of the tuning fork.

With this amendment, it is respectfully submitted that Claims 4 - 18 are all directed to patentable subject matter and that the application is in condition for allowance. Formal drawings will be submitted upon approval of the correction submitted with this amendment.

The Commissioner is authorized to charge any fees required in this matter, including extension fees, to Deposit Account 06-1300, Order No. A-68944/ESW.

Respectfully submitted,

FLEHR HOHBACH TEST
ALBRITTON & HERBERT LLP

By Edward S. Wright
Edward S. Wright
Registration No. 24,903

(650) 494-8700

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Title

[TUNING FORK AND] METHOD OF MANUFACTURING A TUNING FORK WITH REDUCED QUADRATURE ERROR AND SYMMETRICAL MASS BALANCING

Page 4, lines 1 - 2

Figure 3 is a view similar to Figure 2, illustrating the balancing masses [after trimming] being trimmed with a laser to reduce quadrature error.

Page 1, lines 12 - 20

The mass elements can be trimmed by any suitable means such as a laser 30. In one presently preferred embodiment, the tines are fabricated of a material such as crystalline quartz which is transparent to the laser beam, and all of the masses are trimmed from the same side of the fork. Thus, for example, the laser might be positioned on the front side of the fork, with the laser beam 30a passing through the fork to trim elements 28, 29 on the back sides of the tines. Alternatively, if desired, the laser beam can be directed to the back sides of the tines by other means such as mirrors, or by turning the tuning fork over.

Page 6, lines 18 - 24

It is not necessary that the two tines be substantially equal in mass and stiffness prior to adjustment for quadrature offset. If there is an imbalance between the tines, either by design or by errors in fabrication, that imbalance can be corrected by first trimming the mass on one of the tines to eliminate the imbalance, and then trimming equally from both tines for subsequent adjustment. In this way, an inherently asymmetric fork can be corrected as part of the quadrature reduction and frequency adjustment process.

Claims

4. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, and [providing] using balancing masses on the front surface of one tine and the rear surface of the other tine [which reduce quadrature error signal in the rate sensor output and maintain] to eliminate quadrature displacement in the tines while maintaining a balance in mass between the [two] tines.

5. The method of Claim 4 wherein [the balancing masses are provided] quadrature displacement is eliminated and mass balance is maintained by applying mass elements to the [front surface of one tine and the rear surface of the other] tines, and removing portions of the mass elements from the front surface of one tine and from the rear surface of the other.

6. The method of Claim 4 wherein [the balancing masses are provided by applying] quadrature displacement is eliminated and mass balance is maintained by adding mass elements to the front surface of one tine and the rear surface of the other tine.

7. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines having free ends of [enlarged area] increased lateral dimension with laterally offset balancing masses on opposite sides [of the enlarged area of each] of the tines near the free ends, and adjusting the balancing masses on opposite sides of the two tines to [reduce quadrature error signal in the rate sensor output and to maintain] eliminate quadrature displacement in the tines while maintaining a balance in mass between the [two] tines.

8. The method of Claim 7 wherein the balancing masses are adjusted by removing substantially equal amounts of [mass] them from the opposite sides of the two tines.

9. The method of Claim 7 wherein the tines are fabricated of a material which is transparent to a laser beam, and the balancing mass [is removed from] on one side of one of the tines [with a] is trimmed by passing the laser beam [which is passed] through the tine to the balancing mass.

10. The method of Claim 7 further including the step of removing substantially equal amounts of the balancing masses from [the] same sides of the tines to adjust the drive mode frequency of the tuning fork.

11. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming an elongated pair of drive tines having front and rear surfaces, forming a pair of pickup tines having front and rear surfaces, [providing] applying balancing masses [on] to the front and rear surfaces of the drive tines, and trimming the balancing masses on opposite sides of the drive tines to [reduce quadrature offset error] eliminate quadrature displacement without affecting mass balance between the drive tines.

12. The method of Claim 11 further including the step of trimming the masses on [the] same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

13. The method of Claim 11 further including the steps of providing masses on the pickup tines, and trimming the masses on the pickup tines to adjust the pickup mode frequency of the tuning fork.

14. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming a pair of elongated tines which have front and rear surfaces and are disposed symmetrically about an axis, applying balancing masses to the front and rear surfaces of the tines, trimming the balancing masses if necessary to provide a balance in mass between the two tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the tines and from the rear surface of the other to eliminate quadrature displacement in the tines while maintaining the balance in mass between them.

15. The method of Claim 14 together with the step of removing substantially equal amounts of the balancing masses from same sides of the two tines to adjust the drive mode frequency of the tuning fork.

16. In a method of manufacturing a tuning fork for use in an inertial rate sensor, the steps of: forming elongated pairs of drive and pickup tines which have front and rear surfaces and extend in opposite directions from a central body, applying balancing masses to the front and rear surfaces of the drive tines, trimming the balancing masses if necessary to provide a balance in mass between the drive tines, and thereafter removing substantially equal amounts of the balancing masses from the front surface of one of the drive tines and from the rear surface of the other to eliminate quadrature displacement in the drive tines while maintaining the balance in mass between them.

17. The method of Claim 16 further including the step of removing substantially equal amounts of the balancing masses from same sides of the drive tines to adjust the drive mode frequency of the tuning fork.

18. The method of Claim 16 further including the steps of applying balancing masses to the pickup tines, and removing substantially equal amounts of the balancing masses from same sides of the pickup tines to adjust the pickup mode frequency of the tuning fork.